GREGARIOUS BEHAVIOUR IN CRUSTACEAN MICRONEKTON: AN ECOLOGICAL PERSPECTIVE

Aggregations of aquatic crustaceans are customarily regarded as transient phenomena; groupings that have arisen through the agency of hydrological or meteorological factors, or through intermittent intrinsic factors, e.g. need to feed, mate or avoid predators. Small size or low taxonomic level is usually associated with planktonic rather than micronektonic existence. However there is abundant evidence that euphausiids, mysids, decapods and even copepods can exert some considerable influence over their position in the water column and have underrated powers of swimming.

We present evidence to show that many of these organisms are naturally gregarious and that a range of selective forces have favoured gregarious behaviour because of the advantages such associations offer over solitary existence. The principal selective forces are believed to be the same as those invoked to explain fish schooling.

1. Protection from predators. By analogy with fish schools, advantages could accrue from a) early detection; b) attack abatement; c) predator evasion; d) predator confusion (Pitcher, 1986). In addition, if predators are actually deterred from attacking schools or if early detection results in avoidance of the predator before the need for strenuous escape reactions, then there may be a considerable energy saving. There is strong evidence in support of a–d in escape responses of euphausiids and mysids. Aggregations have been shown to modify their antipredator response according to the degree of threat and aggregative state. The fact that school structure is only disrupted when the threat to individuals becomes extreme, is strong evidence for the survival value of grouping.

2. Improved feeding. Again by analogy with fish schools, the advantages should accrue from: a) finding food faster; b) more time for feeding; c) sampling food more effectively; d) information transfer; e) opportunity for copying (Pitcher, 1986). Little direct evidence exists in support of these advantages for gregarious crustaceans. In fact there is some conflicting evidence to suggest that higher foraging and feeding rates in lower density aggregations have to be traded off against safety in large groups. However, these hypotheses are difficult to test because of the problem of creating schools and presenting patchy food distributions in the water column in laboratory experiments.

3. Reproductive facilitation. There are many documented cases of crustaceans apparently aggregated for the purposes of more efficient fertilisation. However, the effect of group size on fecundity and reproductive success has not been tested.

4. Energy conservation. No data are available to test the possibility of hydrodynamic advantage by swimming in schools as has been suggested for fish. The swimming actions of crustaceans are fundamentally different from those of fish. This might be expected to result in differences in nearest neighbour distributions in schools of the two groups if animals were exploiting vortices shed from swimming appendages. No such differences have yet been described

Crustacean schools are strikingly similar to fish schools in internal structure and escape responses. A reluctance to accept that many crustacean species are naturally gregarious, and technical difficulties concerned with maintenance and recording of school behaviour in the laboratory, has delayed rigorous testing of the benefits of schooling as proposed above.

Literature Cited

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EFFECTS OF HYDROSTATIC PRESSURE ON THE TIDAL VERTICAL MOVEMENT OF *ACETES SIBOGAE* HANSEN (CRUSTACEA: DECAPODA)

Acetes sibogae, collected at the mouth of Brisbane River (27°30'S, 153°12'E) and held in the laboratory for a minimum of 10 days, was subjected to three levels (10, 16 and 26kPa) of constant pressure and three (triangular, quadratic and sinusoidal) circatidal pressure regimes with different properties in the rate, relative rate, and acceleration of change, to test two hypotheses: (1) hydrostatic pressure of circatidal frequency and amplitude affects the tidal vertical movement of *A. sibogae* directly and/or through entraining endogenous tidal rhythms, and (2) this shrimp responds to amplitude, rate, relative rate and acceleration of hydrostatic pressure change.

At constant pressures, test animals moved up and down through the water column in the test tank with short, non-circatidal period. In contrast, *A. sibogae* responded to all the three circatidal pressure regimes (triangular, quadratic and sinusoidal) both directly, by vertical adjustment in the water column, and indirectly, by phasing endogenous rhythms in aphasic animals. Both mechanisms allow *A. sibogae* to react both predictively and immediately to pressure changes. The amplitude of circatidal hydrostatic pressure waves was shown to be implicated in initiating the tidal vertical movement of this shrimp, in contrast with the insignificant role of the rate, relative rate, or certain accelerations. This is not surprising since response to the amplitude of pressure change alone is an adequate action as there is great regularity of changes in hydrostatic pressure associated with tides. Such actions allow a predictable response, without the need to monitor changes in the rate, relative rate and acceleration.

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